

REVIEW ARTICLE

# Current status and progress of digital orthopaedics in China



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**Summary** Based on the development of digital medicine and digital anatomy, the concept of “digital orthopaedics” was raised by Pei Guo-Xian in China in 2006. The most striking feature of digital orthopaedics is the combination of basic and clinical orthopaedic knowledge with digital technology. In this review, we summarised the development of digital orthopaedics in China in recent years with respect to: the foundation of the Chinese Association of Digital Orthopedics, virtual human project (VHP), three-dimensional (3D) reconstruction, finite element simulation, navigation in orthopaedic operations, and robot-assisted orthopaedic operations. In addition, we briefly reviewed digital orthopaedics in world leading institutes. We also looked into the future of digital orthopaedics in China and proposed the major challenges in digital technology and application in orthopaedics.

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## Introduction

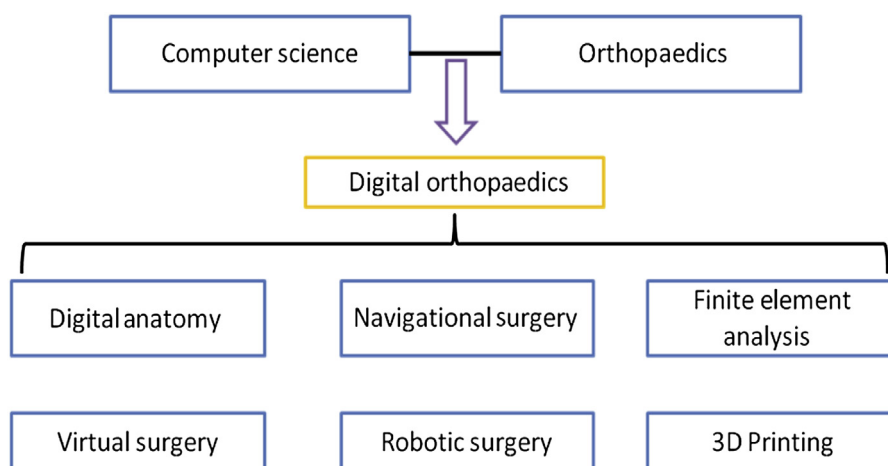
In the course of development of computer science and modern medicine, digital techniques play an increasingly significant role in the diagnosis, treatment, and rehabilitation of diseases. The application of computer science or digital techniques in clinical medicine facilitates the development of medicine. Combining digital techniques and clinical medicine, a new concept called digital orthopaedics is emerging. The main components of digital orthopaedics are shown in Fig. 1.

In 2001, the 174th symposium of the Xiangshan Science Conference was held in Beijing. Academician Zhong Shi-Zhen, researcher Li Hua, and Professor Luo Shu-Qian were the organisers of the conference. The key contribution of this conference was that it proposed a combination of medicine and computer technology to create a new path to the future of medicine, named digital medicine [1].

Researcher Li Hua gave a lecture about the digitisation of an anthropometric dummy, and proposed a concept of a “Chinese virtual human body”. It is known that the human body is complex in anatomical structure and is a challenge for accurate diagnosis and treatment of diseases. All of those were attributed to a lack of an accurate computer model that could simulate the human body in physiological and pathological conditions. Academician Zhong gave a lecture on “the program and technology to build a human

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**Figure 1** The main components of digital orthopaedics.

body model”, in which he pointed out that the first step was to build a three-dimensional (3D) geometric model of the Chinese human body. Professor Luo gave a lecture on “research of a virtual human body and the processing method of medical images”. In the lecture, he introduced a large number of medical image devices which had been developed over years. However, the most challenging part was to integrate these images to form a composite image that could present the characteristics of the human body [2].

All experts realised that the advantages of research in a Chinese virtual human body included: (1) the technology of a human duct cast provided a high-level starting point; (2) the technology to make thin cross-sectional layers of the human body was advanced in China; and (3) the technology of the supercomputer, which could provide a powerful tool for the research, was advanced in China. All experts reached the consensus that Chinese people, representing oriental people, were necessary to carry out the “Chinese virtual human body” project [3].

After the 174th scientific symposium at the Xiangshan Science Conference, the digital technique was extensively applied in all subspecialties. Based on the massive fundamental work, Professor Pei Guo-Xian proposed the concept of “digital orthopaedics” in 2006. The definition of digital orthopaedics was defined as a multidisciplinary science that combines orthopaedics and computer science. The content of this discipline comprised human anatomy, stereometry, biomechanics, material science, information science, electronics, mechanical engineering, etc. [4].

In 2008, the “China Engineering Institute Frontier Academic Conference-Digital Medicine Seminar” was held in Beijing. In the conference, the academic activities of digital medicine were included in the schedule of the China Engineering Institute [5]. In May 2011, The Chinese Medical Association-Digital Medicine Branch was founded in Chongqing, China. Six months later, The Chinese Medical Association-Medical Engineering Science Branch-Digital Orthopedics Study Group (DOSG) was founded in Xian, Shaanxi Province, China. The leader of the DOSG was Pei Guo-Xian.

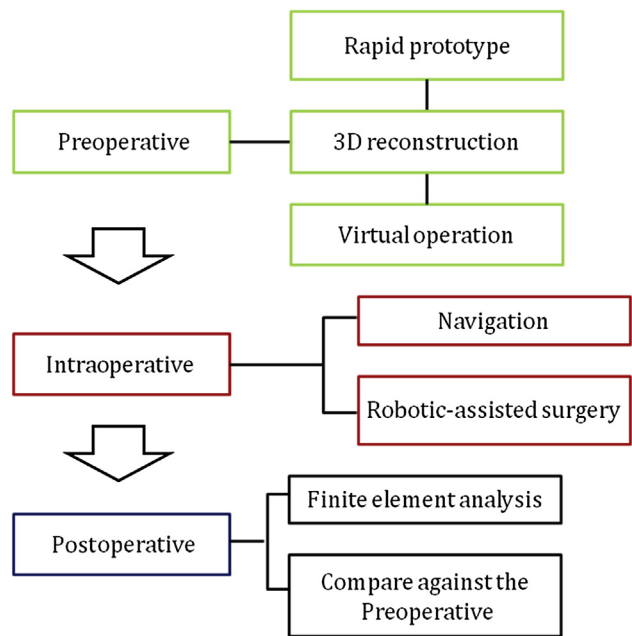
The foundation of The Chinese Association of Digital Orthopedics represented a new beginning of digital

orthopaedics in China. Digital orthopaedics includes many advanced technologies. Digital technologies that can be used by orthopaedists have the potential to be used in digital orthopaedics. The currently advanced digital orthopaedics technologies are as follows: finite element analysis (FEA), digital anatomy, 3D reconstruction, virtual simulation orthopaedic surgery, rapid prototyping technique for orthopaedics, reverse orthopaedic engineering technology, computer-aided design, computer-aided manufacturing, preoperative planning, and so on. These technologies have been widely used in modern orthopaedics, and all subspecialties of orthopaedics were included such as trauma, microsurgery, bone tumour, spine surgery, and joint.

Today, science and technology is developing at a fast speed. Digital orthopaedics is a multidisciplinary specialty in clinical medicine, and collaboration with relevant experts who are knowledgeable in their specialties may enhance development of this technology at a high speed. Digital orthopaedics helps orthopaedists to manage the entire surgical procedure. The whole procedure includes preoperative decisions, intraoperative manipulation, and postoperative management. Technologies in digital orthopaedics include virtual operative planning, computer-assisted navigation in operations, rapid prototype assisted operations, virtual operation training, and so on. In basic research of digital orthopaedics, digital orthopaedic anatomy and biomechanical research will provide basic support for the application of digital orthopaedics. In orthopaedic education and training, digital orthopaedics provides young doctors a virtual tool to improve their operative skills [6]. The application of digital orthopaedics in clinical practice is shown in Fig. 2.

## Burden of DOSG

The DOSG, a nationwide group, affiliated to the Society of Medical Engineering and Chinese Medical Association, is a community-based voluntary health organisation that is dedicated to facilitating the development of clinical and laboratory applications of digital techniques by providing a

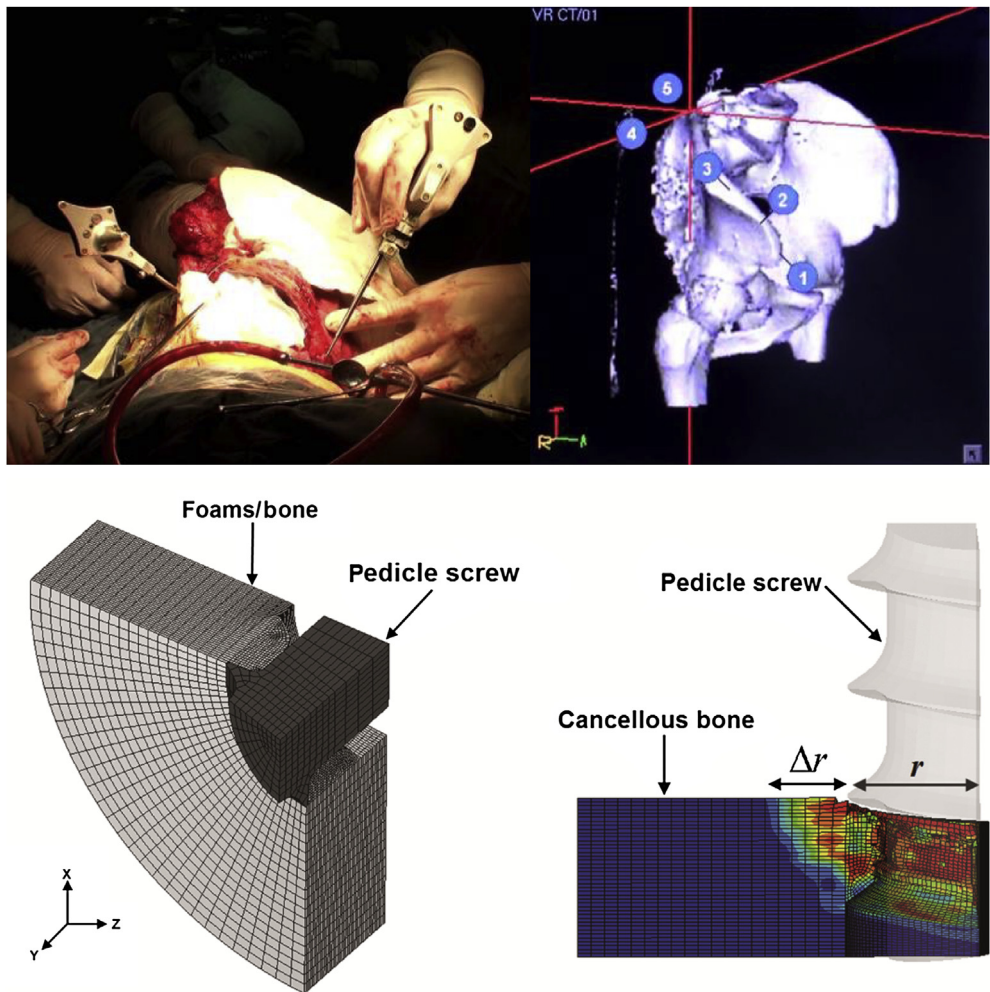


**Figure 2** The application of digital orthopaedics in clinical practice.

communication platform to orthopaedists in China. In addition, to collaborate with other organisations throughout the world, the DOSG also focused on shared strategic directions in the world.

To fulfil the needs of orthopaedists in China, the DOSG held advanced training meetings twice a year. In the training meetings, specialists in digital orthopaedics were invited to give trainees keynotes on the application of their new in clinical and laboratory works. In addition, the workshop was chaired after the meeting by experienced technicians. Every trainee had the opportunity to try the idea they learned from the keynotes and the experienced technicians could fix problems encountered by the trainees. Combining the theory and practice, the advanced symposium of the DOSG could facilitate the dissemination of applications of emerging digital techniques in China [5].

To promote the academic effect, the DOSG held a nationwide conference annually. In the conference, leading scientists in clinical medicine, engineering, and fundamental science extensively discussed the cutting edge of digital orthopaedics. The emerging techniques of biomechanics, surgical navigation and robot-assisted surgery were highlighted in the conference (Fig. 3). The academic conference could promote the development of orthopaedics in China.



**Figure 3** Demonstration of biomechanical simulation and surgical navigation in the workshop.

In May 2012, the first phase of “Advanced Training of Clinical Application of Digital Orthopedic Technology” was held in Xi’an. The content of the training included: definition of digital orthopaedics, the development of digital orthopaedics, clinical application, progress of basic research, image segmentation, preparation of model, rapid casting, navigation in operation, display of Mimics software, and establishment and application of finite element model, etc.

In August 2012, the “Second Digital Orthopedics Conference in Chinese Medical Association” was held in Rizhao, Shandong. This conference was held by The Chinese Medical Association-Digital Medicine Branch. All experts exchanged their viewpoints on the development of digital orthopaedics and new technology in minimally-invasive orthopaedics. Although the digital orthopaedic academic group was established not long ago, nearly 400 young orthopaedists were trained in the workshop and the concept of digital orthopaedics was accepted by most of the orthopaedic surgeons in China.

In addition, the DOSG also encourages academic publications on digital orthopaedics [7]. Under the support of the DOSG, the first monograph of digital orthopaedics in China “Digital Orthopedics” was published in 2009 [8]. Subsequent monographs were “Digital Categorization of Fractures” [9], “Clinical Digital Orthopedics [10]”, and so on. All of these monographs present a summary of the current status of digital orthopaedics in China, and help young orthopaedists to understand digital orthopaedics in a convenient way.

## Development of digital orthopaedics in China

Under the leadership of the DOSG, digital orthopaedics developed rapidly in China. Firstly, the virtual human project (VHP) developed from a visual model to a physical model [11]. Secondly, a 3D reconstruction model was widely used clinically. Thirdly, more and more preoperative decisions were made based on the analytic results of the finite element model. Finally, the application of surgical navigation and robot-assisted orthopaedic surgery was a milestone of digital orthopaedics. The evolution of Chinese digital orthopaedics is reviewed with reference to these four aspects (VHP, 3D reconstruction, FEA, and surgical navigation) in the following.

## VHP

The VHP was first proposed in America. As early as 1989, a cross-section data platform of the human body which encompassed computed tomography/magnetic resonance imaging and histology data was established by the US National Library of Medicine [12]. In 1991 and 1994, a VHP data set was established in Colorado University, which was based on two living bodies of different sexes [13]. This is a first attempt to establish a digital anatomy model that is applicable globally.

Following the American VHP, a visual Korean project was proposed by Korea Ajou University [14]. Researchers in Korea Ajou University accomplished the segmentation of the first male human specimen. This was the second

attempt at developing a virtual human body (Fig. 4), and also included the first data set of oriental people [3].

In China, the first data collection of Chinese male and female bodies was accomplished by the First Military Medical University in 2003[15]. There are six data sets of a digital virtual human body in Shanghai, Chongqing, and Guangzhou in China so far. Based on these data sets, many kinds of application software were developed by the University of Hong Kong, Fudan University, and other leading institutions.

China was the third nation in the VHP. In March 2002, scientists in China initiated the Chinese VHP [22]. After the data collection of the Chinese virtual human, the data were extensively used in all aspects of clinical medicine (Table 1).

Qin and his colleagues [16] established a multi-plane soft tissue model based on the data of the Chinese virtual human. An interactive platform to simulate orthopaedic surgery was provided by this model, which improved the accuracy of simulating surgery.

Shin and his colleagues [17] established a 3D model of lumbosacral vertebrae based on the data of the virtual visible Korean, which showed clearly the anatomic structure of this position. This model can also be used in medical simulations of lumbosacral vertebrae.

Qiu and his group [18] established a visual digital model of temporal bone based on the data sets of the Chinese virtual human body. In addition, the solid model was produced by rapid prototyping technology. This solid model can be used in surgery simulation and clinical teaching.

Chen and his group [19] established the 3D digital model of the liver and the other anatomic structures nearby based on the Chinese visual human body data sets of CVH 1–5. This model encompassed the portal vein, hepatic vein, hepatic artery, inferior vena cava, bile vessel system, and so on. Operators can perform many procedures on this model, including rotation, amplification, and segmentation.

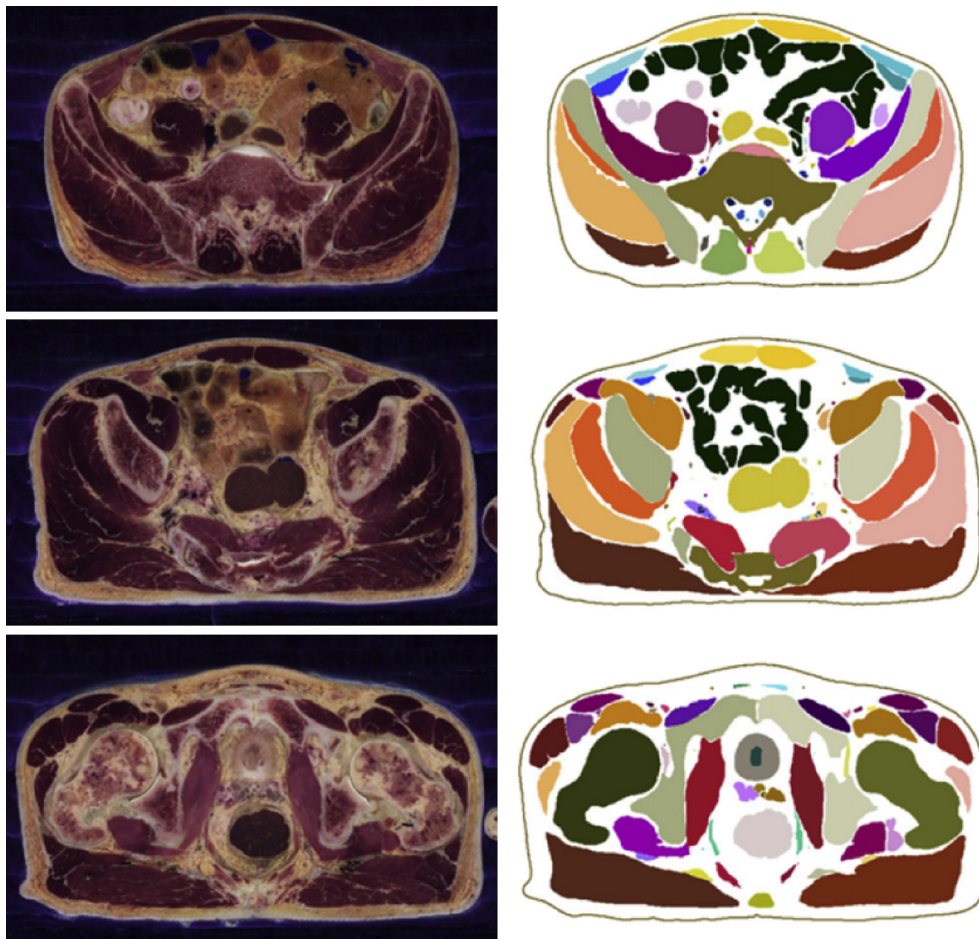
Li and his colleagues established a digital visual model of parapharyngeal space according to data sets of the Chinese visual human body, which showed clearly the anatomical relationships among the parapharyngeal space, parotid gland, muscles, mandibular bone, and vessels [20].

Wu and his group [21] established a 3D digital visual model of the prostate gland with the other anatomic structures nearby with 3D-Doctor software based on the data of Chinese visual human bodies. This model provides a morphological basis on the radiological diagnosis and urinary surgery operation.

In China, a digitised 3D model of a virtual lumbar region and its adjacent structures was established to assist anatomical study and virtual surgery. In a recent study, a recently developed human body model, the Global Human Body Models Consortium mid-sized male, was used to examine chest band contour deformations in a frontal and lateral impact [23]. Virtual human technology was used to research whether sex, race, or body posture influenced pain management decisions [24].

The virtual human is a methodological and technological framework that, once established, will enable collaborative investigation of the human body as a single complex system. The collective framework will make it possible to share resources and observations formed by institutions and





**Figure 4** Sectioned and color-coded images of the visual Korean project.

organisations creating disparate but integrated computer models of the mechanical, physical, and biochemical functions of a living human body [25].

In the future, it is hoped that the VHP will eventually lead to a better healthcare system, which aims to have the following benefits: personalised care solutions, reduced need for experiments on animals, more holistic approach to medicine, and a preventative approach to the treatment of disease.

### 3D reconstruction

3D reconstruction was the core technique in the digital technique (Fig. 5). In clinical practice, 3D reconstruction based on the DICOM images plays a pivotal role in the diagnosis and treatment of diseases (Fig. 6). Compared with 2D images, the 3D reconstruction is more accurate and sensitive in the diagnosis of complicated fractures and deformities. It makes 3D reconstruction more advantageous clinically [26].

Advances in 3D imaging now provide the radiologist and referring physician with the ability to create accurate 3D models of any part of the human body. The major area of clinical applications of 3D imaging has been in orthopaedics. This technology has been used in clinical operations to provide accurate information for the surgeon. The use of a

3D model has been well described for craniomaxillofacial reconstruction, especially with the preoperative planning of free fibula flaps [27]. It can also be used to assess the effect of operation on anatomy [28]. Dong et al [29] proposed a detailed protocol for building a subject-specific 3D model of a knee joint from a living individual. The computed tomography and magnetic resonance imaging image data of the knee joint were used to reconstruct knee structures, including bones, skin, muscles, cartilages, menisci, and ligaments. They were fused to assemble the complete 3D knee joint.

3D reconstruction played a significant role in the clinical work. However, the flaws of 3D reconstruction may include a potential risk of radiation [30]. It is imperative to model the human musculoskeletal system based on a small radiation dosage. Therefore, the future of 3D reconstruction is to: (1) reconstruct the 3D model based on the minimal slices; and (2) reconstruct the 3D model based on the X-ray plain. The 3D reconstruction will be more popular once it overcomes the radiation risk.

### Finite element simulation

FEA is a method to computationally model reality in a mathematical form to better understand a highly complex problem (Fig. 7).

**Table 1** The application of the Chinese visual human body.

Authors	Model	Year	Significance
Qin et al [16]	Multi-plane soft tissue model	2010	Improve the accuracy of simulating surgery
Shin et al [17]	Lumbosacral vertebrae	2011	Medical simulation of lumbosacral vertebrae.
Qiu et al [18]	Temporal bone	2004	Surgery simulation and teaching
Chen et al [19]	Liver	2010	Anatomic teaching
Li et al [20]	Parapharyngeal space	2004	Anatomic teaching
Wu et al [21]	Prostate gland	2010	Radiological diagnosis and urinary surgery operation

Research in different areas of orthopaedic and trauma surgery requires a methodology that allows both a more economic approach and the ability to reproduce different situations in an easy way. Simulation models have been introduced recently in bioengineering and could become an essential tool in the study of any physiological unity, regardless of its complexity [31].

The main problem in modelling with finite element simulation is to achieve an accurate reproduction of the anatomy and a perfect correlation of the different structures, in any region of the human body [32]. Finite element simulation lets us know the biomechanical changes that take place after hip prostheses or osteosynthesis implantation and biological responses of bone to biomechanical changes. The simulation models are able to predict changes in bone stress distribution around the implant, so allowing preventing future pathologies. The development of an FE model of the skeleton is another interesting application of the simulation. The model allows research on the skeleton system, not only in physiological conditions, but also simulating different load conditions, to assess the impact on biomechanics. Different degrees of disc degeneration can also be simulated to determine the impact on adjacent anatomical elements (Fig. 8). Finally, FE models may be useful to test different fixation systems, i.e., pedicle screws, interbody devices or rigid fixations compared with dynamic ones.

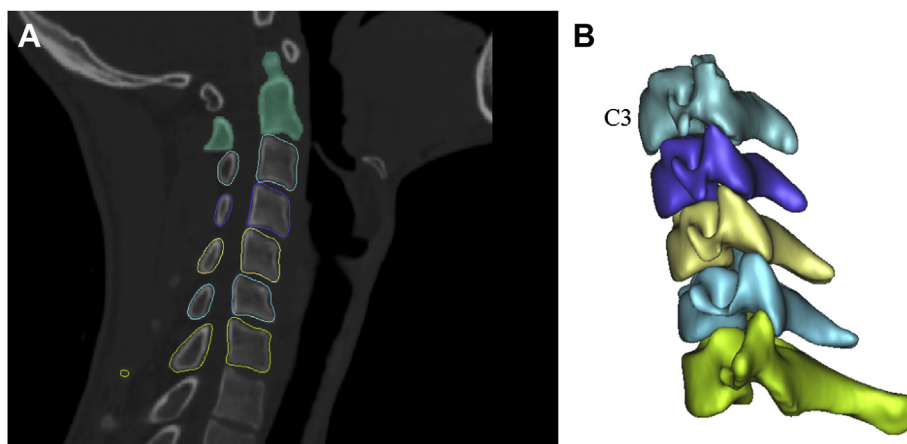
FEA was extensively applied in skeleton modelling in China. Scientists in China have established a significant number of skeleton models. Ren et al [33] established and validated a nonlinear FE model of the upper cervical spine.

Their model realistically simulated the complex kinematics of the craniocervical region, which could simulate the natural conditions and facilitate further biomechanical research. They also established an FE model of an axis odontoid fracture. According to the clinical characteristics of an odontoid fracture, various boundary conditions and loads were applied. They found that the loads in anterior parts were inclined to cause both type II and III odontoid fractures, whereas the posterior loads were more inclined to cause the latter type. Guo et al [34], at the author's Xijing Hospital, evaluated the biomechanical effect of hemipelvic tumour resection based on the FEA. In this study, the FE model of the pelvis reconstructed with implants was established. We demonstrated that the FEA could provide accurate biomechanical guidance to the reconstruction of the pelvic ring in bone tumour resection operations.

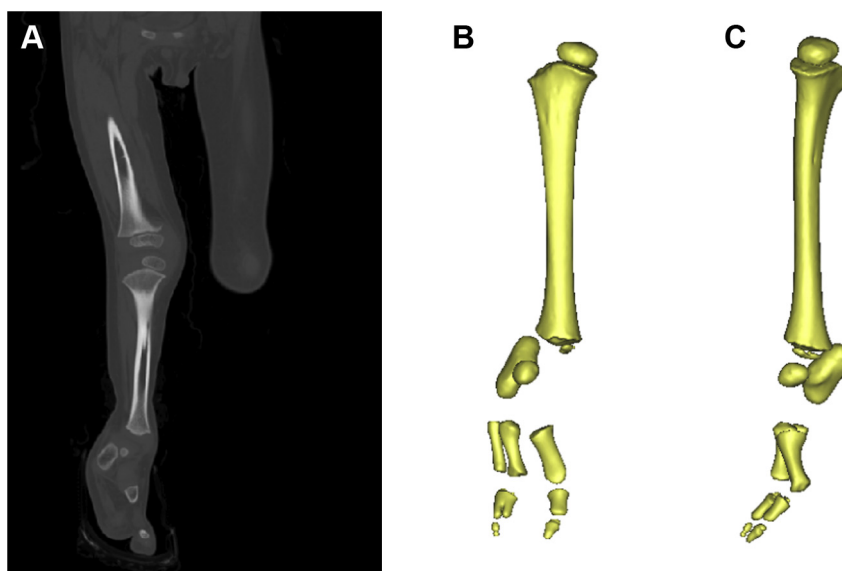
FEA has been widely used to assess the biomechanics of implants. It can also be used to predict bone strength, which is very important in the development of osteoporosis [35]. Due to recent developments in FE model generation, for example, improved computed tomography imaging quality, improved segmentation algorithms, and faster computers, the accuracy of FE modelling has increased vastly, and FE models simulating the anatomy and properties of an individual patient can be constructed.

### Navigation in orthopaedic surgery

Navigation in surgery has emerged as one technology that continues to transform surgical interventions into safer and



**Figure 5** Computed tomography and three-dimensional (3D) model of the cervical spine. (A) Sagittal image of the cervical spine; and (B) 3D model of the C3–C7 section of the cervical spine.

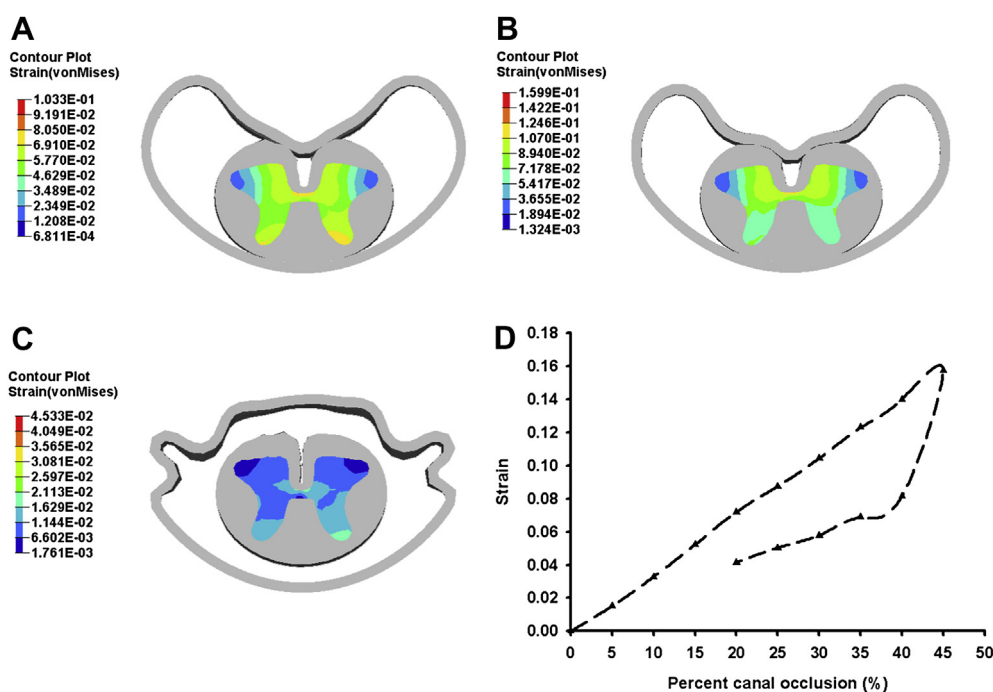


**Figure 6** Three-dimensional (3D) images can provide more information than 2D images. (A) Coronal image of lower extremity deformity; (B) anterior view of the deformed foot and ankle; and (C) lateral view of the deformed foot and ankle.

less invasive procedures. Navigation is a relatively recent addition to the surgeon's tool box. Navigation in surgery was born from the desire to perform safer and less invasive procedures. Navigation in surgery is an important surgical decision-making tool, which has evolved hand-in-hand with the fresh approaches it enables surgeons to perform [36].

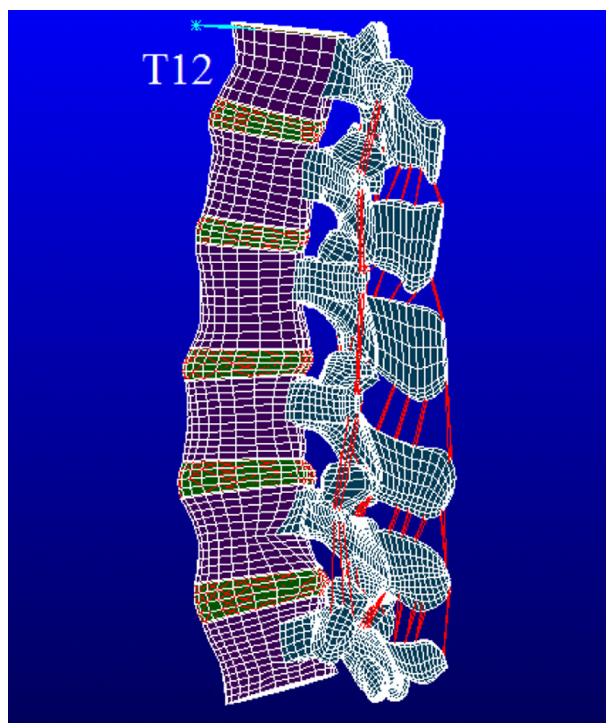
In China, the navigation technique was extensively applied in orthopaedic surgery in the laboratory and clinic. Lopomo et al [37] at Beijing Jishuitan Hospital and Laboratorio di Biomeccanica, assessed the hip joint centre in the laboratory by the navigation technique. In their study, a

navigation system was used to acquire data on the cadaveric hips and the positions of the hip centre were evaluated. They found that the navigation technique could significantly improve the accuracy of the estimation of the hip centre. The navigation technique was also applied in clinical work. Ye et al [38] treated the atlantoaxial instability with a posterior C1–C2 transarticular screw by intraoperative 3D fluoroscopy-based navigation. Their study concluded that intraoperative 3D fluoroscopy-based navigated screw fixation was both feasible and safe. The procedure could achieve greater precision and minimal invasion combined with



**Figure 7** Finite element analysis shows the stress distribution in the grey matter of the spinal cord under dynamic impact.





**Figure 8** Finite element model of the lumbar spine (T12–L5).

minimally invasive techniques. This technique could also assist the surgeon in the reduction of the fracture. Ruan et al [39], at Shanghai Sixth People's Hospital, demonstrated the application of 3D fluoroscope navigation on percutaneous screw fixation for an acetabular fracture. They found that this technique could achieve better results and no complication was noted postoperatively. However, the navigation technique also had its inherent limitations. Cheng et al [40], at the Shanghai Sixth People's Hospital, compared the radiographic outcomes of total knee arthroplasty (TKA) performed using imageless computer-assisted navigation compared with conventional techniques. Their results indicated that imageless computer-assisted navigation systems improve lower limb axis and component orientation in the coronal and sagittal planes, but not the rotational alignment in TKA and further multiple-centre clinical trials with long-term follow-up are needed to determine differences in the clinical and functional outcomes of TKA performed using computer-assisted techniques. In addition, to address the debate about the use of computer navigation systems in the anterior cruciate ligament (ACL), Cheng et al [41] also systematically reviewed the computer-navigated surgery in ACL reconstruction. They found that there was no evidence of statistical differences between the navigated and conventional ACL reconstructions on the placement of the tibia tunnel. However, the risk of notch impingement was reduced in the navigated group. In addition to the computer-navigated surgery, Zhang and his team [42] proposed a novel application of the navigational templates in orthopaedic surgery. They designed a novel template for ensuring accurate prosthesis implantation in hip resurfacing arthroplasty by means of 3D reconstruction and reverse engineering.

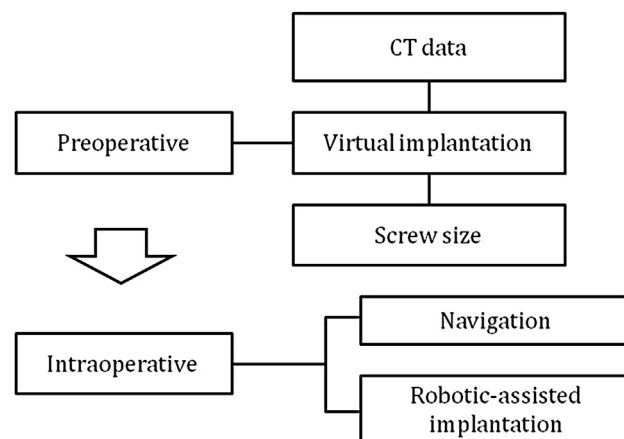
The surgeon's quest for safer, less invasive and more cost-efficient procedures has come a long way and continues to move forward at an unprecedented pace in China. Over the past decade, navigation in orthopaedic surgery has evolved beyond imaging modalities and bulky systems into the rich networking of the cloud or devices that are pocket-sized. Such advances have only been made possible by close collaboration between technological companies and surgeons. Navigation in surgery is already the standard of care for a variety of disciplines. In the near future, with improved computer technology and a trend towards advanced information processing, navigation will soon be increasingly integrated into surgical routines.

### Robot-assisted orthopaedic surgery

Robotic surgery, computer-assisted surgery, and robotically-assisted surgery are terms for technological developments that use robotic systems to aid in surgical procedures. Robotically-assisted surgery was developed to overcome the limitations of minimally-invasive surgery and to enhance the capabilities of surgeons performing open surgery [43]. The flowchart of typical robotic-assisted orthopaedic surgery is demonstrated in Fig. 9.

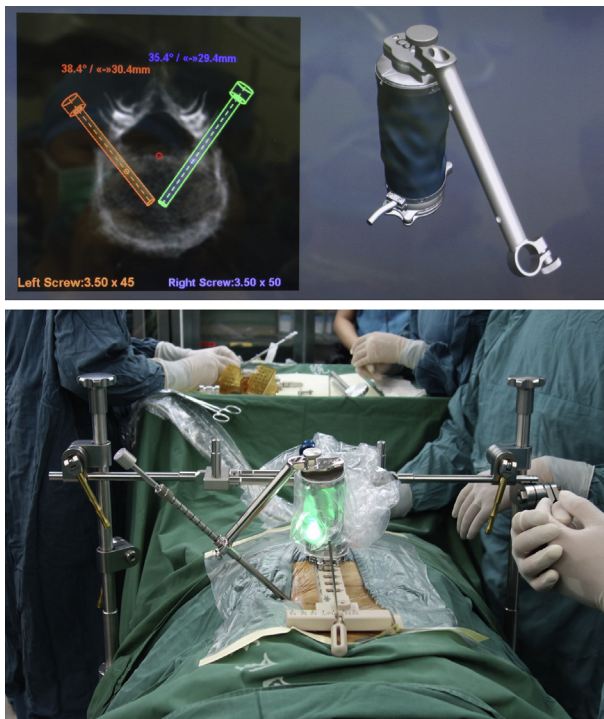
Technology is revolutionising the medical field with the creation of robotic devices and complex imaging. A robot is defined as a computerised system with a motorised construction (usually an arm) capable of interacting with the environment. In its most basic form, it contains sensors which provide feedback data on the robot current situation, and a system to process this information so that the next action can be determined. The key advantage of robotic surgery over computer-assisted surgery is its accuracy and ability to repeat identical motions [44].

In China, the robot-assisted technique was extensively explored and increasingly applied in orthopaedic surgery. The Mazor robotic surgery system was carried out in China in 2014. The orthopaedic surgeons in the Xijing Hospital performed the spine operation and bone tumour resection under the support of the Mazor robotic surgery system (Fig. 10). Xiaojun et al [45], at Shanghai JiaoTong University, designed an image-guided oral implantology system (IGOIS) to transfer the preoperative plan accurately to the



**Figure 9** The outline of robotic orthopaedic surgery.





**Figure 10** The Mazor robotic surgery system used in spine surgery.

operating theatre. In their IGOIS, the framework, 3D-reconstruction, preoperative planning, registration, and the motion tracking algorithm were integrated. The phantom experiment shows that the errors were significantly small. In their clinical application, the IGOIS system was proved to be accurate, reliable, and flexible. To improve the bone-sawing skill of surgeons, Lin et al [46] designed a surgical simulator. In their research, a surgical training simulator with virtual and haptic force feedback for maxillofacial surgery was developed. The effect on the learning of bone-sawing skills through empirical evaluation was validated. Their study could provide a training method for users to perform bone-sawing operations with stable hands and sensitive force perception. The robotic-assisted technique applied not only in the training procedure, but also applied in clinical work. Zhang et al [47] designed a novel robotic mechanism for total knee replacement surgery. The mechanism consisted of three components: articulated manipulator, bone clamp, and mechanical support arm. The performance of the prototype shows that the compact mechanism can solve the problem of the conventional robot system occupying a large space in the operating room and prohibiting flexible movement between the patient's femur and the robot. Han et al [48], at Beijing Jishuitan Hospital, evaluated the robot-assisted reduction for femoral shaft fracture. Their study demonstrated that the accuracy of robot-assisted reduction could satisfy the clinical requirement and the robot could maintain the resulting reduction status. During the reduction procedure, no addition of C-arm fluoroscopy was needed, and therefore, the X-ray radiation dose could be minimised.

Other advances of surgical robots have been remote surgery, minimally invasive surgery, and unmanned surgery. Due to robotic use, the surgery is done with precision,

miniaturisation, smaller incisions, decreased blood loss, less pain, and a quicker healing time. Articulation beyond normal manipulation and 3D magnification results in improved ergonomics. Due to these techniques, there is a reduced duration of hospital stays, blood loss, transfusions, and use of pain medication [49]. Robot-assisted surgery has the potential to improve patient outcomes, increase efficiency, and reduce complications [50]. Future studies involving robot-assisted surgery should focus on minimising the duration of operations and reducing cost.

### The future of digital orthopaedics in China

Digital orthopaedics in China have developed slowly but robustly. Applying the digital technique in clinics has attracted a lot of attention for further research and development in the laboratory and wider clinical applications. Digital techniques have been extensively applied in a variety of subspecialties of orthopaedics in China, such as the spine, joints, trauma, tumours, and paediatrics. The significant role of the digital technique is irreplaceable. In many institutes and hospitals, daily work depends a lot on the digital technique.

However, there are still some limitations of the digital technique for clinical applications. The following are major drawbacks that limit further development of digital orthopaedics in China: (1) the gap between the clinical medicine and engineering is difficult to overcome, due to insufficient communications between medical doctors and engineers, where engineers have difficulties in understanding the clinical requirements; (2) although digital techniques (e.g., VHP, FEA, navigation, robot-assisted surgery) have been extensively applied in the laboratory and clinics, we just played a role of user, not a developer. The mainstream software and hardware of digital orthopaedics were mostly designed and developed abroad. Therefore, a lack of in-depth scientific research limited the development of digital orthopaedics in China; (3) the transition of laboratory discovery to clinical application is not limited in China, due to a lack of original innovation in both software and hardware development in China; and (4) owing to the expensive hardware and techniques demanding manipulation, the digital orthopaedic technique is limited in the large-scale medical centres in the big cities in China.

In the near future, under the support and push of the DOSG, a rapid developmental period of the digital technique will soon be in China. First of all, workgroups with a different duties will be established. The DOSG will consist of an FEA workgroup, a navigation workgroup, and a robot-assisted surgery workgroup. The duties of different working groups are cross-linked. Secondly, to promote application of the digital technique, the DOSG would organise conferences and workshops regularly. The training courses could help orthopaedic surgeons in the application of the digital technique. Thirdly, the DOSG is committed to developing digital orthopaedics and popularising the clinical application of digital techniques. Many training and application centres for digital orthopaedic techniques will be established in China. The digital technique will be applied extensively in clinical work in comprehensive medical centres in 5–10 years in China.

## Conflicts of interest

All authors declare no conflicts of interest.

## Acknowledgements

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